



UNITED STATES
ATOMIC ENERGY COMMISSION

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6-15

IN REPLY REFER TO:

OE:KKEE

Oak Ridge, Tennessee, 37831
June 11, 1964

Union Carbide Corporation
Nuclear Division
P. O. Box X
Oak Ridge, Tennessee, 37831

Attention: Dr. J. A. Swartout, Deputy Director
Oak Ridge National Laboratory

Subject: USAEC-ORO SAFETY REVIEW OF THE ORNL OPERATIONS DIVISION REACTORS

Gentlemen:

Enclosed for your review and consideration are ten (10) copies of the subject report. ORNL comments on the draft copy of this report were considered in the preparation of the final report.

The review committee has determined that the Operations Division reactors are continuing to be operated in a safe manner. We wish to express our appreciation for the cooperation and assistance given the committee by the management and staff of the Operations Division during the review.

Please reply by September 1, 1964 advising us of the actions planned or accomplished relative to the committee's recommendations. I would also be pleased to receive any comments that you might have concerning the conduct of the review or the presentation of the report.

Very truly yours,

Herman M. Roth

Herman M. Roth
Director
Research and Development Division

Enclosure:
Subject Report (10)

cc: C. E. Larson, UCC-ND, w/encl.
R. C. Armstrong, w/encl.
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This document has been approved for release
to the public by

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1/31/90
Date

USAEC-ORO

Safety Review of the
ORNL Operations Division Reactors

April 21-24, 1964

I. Summary and Recommendations

Operational highlights during the past year included the shutting down of the Oak Ridge Graphite Reactor (OGR) on November 4, 1963, after twenty years of service, detection of radiation damage in the Oak Ridge Research Reactor (ORR) beryllium reflector core pieces, the unintentional meltdown of a fuel plate in the ORR, test installation of an advanced design ORR control rod drive, and the initial operation of the GCR-ORR Loop II Test Facility.

Major programs nearing completion include the Low Intensity Test Reactor (LITR) containment project, the LITR instrumentation upgrading program, the revision of the LITR and the ORR off-gas systems, and replacement of the ORR rod drives.

The Operations Division has instituted an operator certification program and is revising the training program to include a programmed instruction technique.

The Committee reviewed the operation of the reactors since the previous annual review and is of the opinion that the reactors are being operated in a safe manner.

The Committee believes that the revised mechanical maintenance procedures at the ORR are of safety benefit and recommends that this system be applied at the LITR without undue delay.

Revised procedures aimed at controlling inadvertent entry of materials into the reactor core are in effect at the ORR. It is recommended that LITR procedures be revised in a similar manner.

In addition, the Committee maintains a continuing interest in programs such as the ORR rod drive replacement and the LITR instrumentation changeover. The Committee requests that it be provided, in a timely manner, with copies of the available reports on the results obtained with the prototype ORR rod drive and with information concerning the new LITR nuclear instrumentation system.

II. Introduction

The annual safety review of the ORNL Operations Division reactors was conducted during the period of April 21-24, 1964. Reactors included in this review are: Oak Ridge Research Reactor, Low Intensity Test Reactor, and the Oak Ridge Graphite Reactor. Review meetings and inspection trips were scheduled with the assistance of R. G. Affel, Radiation Safety and Control Division, and J. A. Cox, Operations Division Superintendent. The Review Committee, consisting of Gene P. Coryell, ORO, Chairman; Kenneth E. Elliott, ORO; and H. N. Culver, TVA (Consultant), had several meetings with R. G. Affel, J. A. Cox, W. R. Casto, W. H. Tabor, and other staff members of the Operations Division and the Radiation Safety and Control Division.

III. Discussion

The Committee reviewed the organizational and administrative changes made during the last year and it was found that the organization remains as described in References 1 and 2. Administrative program developments are as follows:

A. Training Program

The reactor operator training and certification program, closely paralleling 10-CFR-Part 55 requirements, has been established. Two ORR-LITR shift engineers have been certified this year compared with six during the previous four years. Other operating crew members are participating in the certification program. The educational sections of the training program are being used as texts and concurrently are being revised using a programmed instruction technique. The section on Radiation Safety and Control was completed sometime ago and Reactor Physics was completed last month. The section on Heat Transfer is scheduled for completion this spring and Instrumentation and Controls is scheduled for this summer.

B. Reactor Safety Program

Various aspects of the ORNL reactor safety program as related to the ORR and LITR were discussed.

Summary reports of the reactor facilities reviews performed by the Laboratory Director's standing safety committees are now provided the AEC. It was noted that the Reactor Operations Review Committee's (RORC) thorough review of the ORR had placed particular emphasis on containment and on criticality control.

Mr. Tabor reviewed the Operations Division safety program noting that all members of the division actively participate and that primary emphasis is on accident prevention; however, many of the recent operating procedure and emergency procedure revisions are of the "consequences limiting" type.

In response to committee questions regarding surveillance and control of reactor effluents, Mr. Affel reviewed the status of the Laboratory-wide radiation warning and communication project, noting that all stack ducts are equipped with filters and monitoring instruments and that facility contamination alarms and facility radiation alarms systems are telemetered into the Building 2500 emergency control center.

Operations Division plans call for the completion of major projects at both the LITR and the ORR in the next one or two shutdown periods.

The Committee expressed some concern over the safety implications of accomplishing several major changes in a short time period. Mr. Casto explained that the shutdown planning committee was considering this problem and planned to allow a suitable test period for each project. For example, the LITR instrumentation changeover will be made only after the Operations Division has received and evaluated the I&C Division review describing the system, specifying design and acceptance criteria, and providing a changeover procedure. The Operations Division will carefully restrict core changes or other revisions during this shutdown so that system tests will be made under known reactor conditions. Other major changes will be handled in a similar manner.

It is this Committee's opinion that the reactor safety program is being effectively applied at Operations Division facilities.

C. Response to Previous Review Recommendations

1. A lock and tag procedure has been developed and is included in the operating procedure manual.
2. An ORR Operating Safety Limits document (ORNL-TM-689) was issued on October 11, 1963. A similar LITR document is now being reviewed and should be issued in the near future.
3. Experiment leads to the LITR reactor tank have been removed from the top of the reactor and relocated to enter the reactor tank through special access ports. This results in easier access to the reactor core and control rod drives as well as more favorable conditions for the experimenter.

D. ORR Operations

1. Fuel Plate Melting Incident

On July 1, 1963, at a beginning-of-cycle startup, an incident occurred which resulted in the partial melting of one fuel element plate with consequent release of fission products into the reactor water system. The incident was caused by a neoprene gasket which came loose from a blank flange on the reactor tank and lodged in the upper end box of a fuel element resulting in coolant flow blockage at the element. As the power level of the reactor was increased, several fluctuations of the servo system were noted by the operator but these were attributed to servo system disorders (which had been observed previously) instead of boiling of coolant in the reactor core. A visual inspection of the reactor core at a power level of 6 Mw failed to detect any abnormalities. This is understandable due to the small viewing port then located in the reactor tank lid and the fact that the affected element was in core position D-1 which is at the extreme end of the core.

When the reactor power reached 24 Mw, cooling system radiation monitors and continuous air monitors in the building began to alarm. The reactor was scrammed, the building containment system was actuated, and the building was evacuated. All instrumentation and emergency equipment operated satisfactorily. Only noble gas fission products were detected inside the building. Iodines presumably went through the degasifier system, the scrubber, and were released from the 250 foot stack. Monitoring instrumentation at the stack indicated a release of about 150 mc of iodine.

Postincident examination of the fuel element in the hot cell revealed that less than 2 grams of one fuel plate had melted. A second demineralizer system was added and both were used to remove contaminants from the water system. Small deposits of contamination still exist in the cooling system causing localized radiation problems in some components of the system. However, no overexposures to personnel have resulted from this incident.

Several actions have been taken to prevent similar incidents at the ORR. These include:

- a. Procedures to control any material entering reactor pool, to prevent loss of items from experiments, and to prevent the inadvertent entry of materials to the pool or reactor tank.
- b. A second viewing port has been added in the reactor tank lid which permits wider inspection of the whole core.
- c. The gamma measuring channel installed to monitor N-16 in the exit water indicated the incident very clearly and it is planned to redesign the channel to be comparable with other protective instrument channels.
- d. The degasifier system has been modified so that effluent from the degasifier goes into the equalizer leg of the pool system instead of the outlet water line of the reactor as previously. This modification should reduce the amount of fission gases reaching the reactor pool by a factor of 10 or more.

2. Beryllium Bowing in the Core

During the past year, it was discovered that some beryllium shim rods and reflector elements were difficult to remove from the core due to bowing. Examination in the hot cell indicated that several of the reflector elements which had been in the core several years were bowed significantly, in one case up to 50 mils.

A program is now underway to replace all beryllium core pieces which have bowed greater than about 10 mils. To date, about one-third of the inventory has been checked and 7 pieces have been changed. The remaining pieces will be checked and it is planned to routinely shuffle the core pieces to obtain a more uniform exposure.

Both beryllium-cadmium control rods have been replaced by aluminum-cadmium control rods. These newer rods are worth about 2.5% $\Delta k/k$ each as compared to about 3% $\Delta k/k$ each for the old rods. In addition, the new rods show less shadowing effect than the older ones.

3. Rod Drive Replacement

Problems with control rod drives have been experienced since early operation of the ORR. Some of these include: failures of the scram-latch mechanism to release, release for unknown reasons, and failures of the mechanism to recock.

A design and development program has been in progress since August 1961 for the purpose of providing improved control rod drive mechanisms for the ORR. An improved rod drive has been developed which incorporates many of the advantages of the old drive plus extra features that include: splatterproof magnet and improved bellows, redesigned ball-latch mechanism, a snubber unit (hydraulic piston and spring) to prevent thermal expansion problems, and improved O-ring seal unit with provisions for draining, if desired.

The new drives have been extensively tested on the test stand and have been reviewed by the Reactor Operations Review Committee. A prototype of the drive is installed as the servo controlled rod in core position D-6. The unit was tested extensively and performs quite well. Reproducibility tests were exceptional; for example, magnet release times were reproducible within a few tenths of a millisecond.

Installation procedures and current rod drive test information will be reviewed prior to installation of the six new units. The operations group estimated that two weeks will be required to install the new drives and perform all the necessary tests. At present, operators and maintenance men are being trained with the new drives and actually disassemble and reassemble them on test benches.

4. Containment

Because of suggestions from the RORC, the operations group is investigating containment aspects of the ORR building. A

long-range program is underway to determine leakage characteristics of the building, including the effects of wind pressure and temperature due to solar heating of the metal roof and building sides.

There are three methods of placing the building in containment. These are:

- a. A manual switch.
- b. An ionization chamber in the top portion of the building.
- c. A detector that looks at a sample of gas just upstream of the scrubber.

During the incident of last July, the building was placed in containment and equipment performed as expected. No fission gases were detected outside the building.

5. Instrumentation Changes

The most significant instrumentation changes were:

- a. A second poolside fission chamber and counting channel was installed and are performing satisfactorily.
- b. A limited range gain adjustment for safety amplifiers now provides an accurate method of changing channel sensitivity. Safety chambers are positioned manually infrequently and only when a coarse adjustment is required.
- c. Pilot lights have been installed in the reactor scram circuits to indicate when a slow scram is actuating both hot and neutral sides of the magnet amplifier AC supply.
- d. A new dual ion chamber has been installed near the core. This consists of two chambers in one enclosure. The compensated section is used for the #1 Log N channel and the uncompensated section will be used for a safety level channel. The dual chamber has performed well and meets reliability criteria; consequently, it will be made part of the safety circuitry.

6. Test Facilities

The GCR-ORR Loop II, installed in the south engineering test facility, operated quite satisfactorily for several months during the past year but has been shut down since November 1963 because of lack of funds. The installation was reviewed by the Laboratory's Reactor Experiment Review Committee (RERC), the RORC, and the ORO Reactor Safety staff prior to its initial operation.

The north engineering test facility is being converted into two neutron beam facilities. Fuel elements were moved inward in the core and beryllium reflector elements were placed at the edge of the core near the beam tubes.

7. Mechanical Maintenance

The mechanical maintenance procedures seem to be greatly improved since the last safety review. A computer system has been set up to schedule periodic inspections, preventative maintenance, and lubrication times. A system of double checking the computer cards prevents losing cards and assures that records are kept up-to-date.

The Operations group has daily and weekly equipment checklists and each shift inspects critical equipment, and reports any abnormal readings or operation. Maintenance repair records are kept up-to-date and data sheets that include manufacturers instructions and installation prints are maintained for major pieces of equipment.

Several major mechanical maintenance repairs and changes have been made during the past year. These include:

a. Installation of Mission Check Valves

At the high coolant flow rates necessary for 30 Mw operation, the originally designed check valves caused water hammer problems. The Mission check valves are being installed to prevent these problems. The last of these will be installed during the June shutdown.

b. Degasifier System Modifications

These were described under Section D.1 above.

c. Gasket Deterioration in Reactor Primary System Strainers

The strainer baskets were found to be improperly seated and to contain scraps of neoprene gasket material. The pieces

of gasket material were removed and the strainers were properly seated. In addition, the gasket design was sized so that a minimum amount of neoprene was exposed to the water. Small pieces of gasket material which had been noticed in the reactor core previously were probably from this source.

E. LITR Operations

1. Instrumentation Changes

Operation of the LITR from the new remote console in the ORR control room was started in October 1963 following a one-month test and training period in which both the local and the remote consoles were manned. The new process instrumentation for the LITR was connected to the control system at this time and has performed well. The new nuclear instrumentation is not yet connected to the control consoles. This changeover plan was discussed in Section III.B. The new instrumentation embodies the current concept of separate dual channels for all safety systems.

2. Containment

Several changes in the LITR containment building have been made during the past year. The side of the building which had been open to the weather has been closed and truck doors installed at that end of the building. Both east and west experimental rooms have been painted with a crack-sealing-type paint, windows have been blocked off, and doors have been gasketed in order to provide better seals. An extra set of air-lock doors have been installed in the area at the top of the reactor. The old windows have been replaced with large picture windows which are sealed around the edges. Work on building containment is continuing and, when this is finished, the ventilation system will maintain a negative pressure in the containment building.

The normal off-gas system (NOG) and the pressurizable off-gas system (POG) have been tied in with the ORR systems. Since the OGR has been shut down, the LITR no longer uses the Graphite Reactor stack.

3. Miscellaneous

No beryllium reflector damage has been observed in the LITR. None is expected in the near future because of the lower flux levels and less heating than is experienced in the ORR. However, this problem will be kept in mind since the MTR, of which LITR is a prototype, has experienced extensive beryllium damage. The MTR, however, operates at significantly higher powers than the LITR.

The old reactor ΔT system was affected by changes in cooling when fan adjustments were made. The new system is more stable because the sensors were relocated; the inlet temperature bulb is now on the "spider" ten feet down in the reactor tank.

F. OGR Operations

1. Reactor Shutdown

On November 4, 1963, twenty years from the day that it first went critical, the OGR was shut down permanently. The aluminum-clad fuel slugs still remain in the reactor and several precautions have been taken to prevent the reactor from being started up inadvertently. Warm air is constantly drawn through the slug channels to prevent moisture from causing corrosion of the cladding. The dew point, metal temperature of the fuel, bulk air temperature, and exit air duct radiation level are constantly monitored.

To insure that the reactor remains shut down even with all control rods withdrawn, an eight-foot-long boron-steel rod was placed in each of four horizontal experiment holes and these holes were locked and sealed. In addition, the drives of the safety and control rods were inactivated. Tests were conducted and it was determined that the reactor would be shut down by at least 300 in-hours ($\sim 0.8\% \Delta k/k$) even with all the control rods withdrawn.

2. Reactor Penetrations

In order to prevent occurrences outside the reactor shield from causing problems within the reactor, all process piping and conduits which penetrate the reactor shield have been cut and/or blocked off. Experiment and access holes have been sealed and locked. Regular checks are made of these facilities to insure that they are not violated.

IV. Inspection

A. LITR

1. Console and Process Instrumentation Rooms

Instruments at the old console were running and were being watched by an operator. New wiring was observed which led to the new console in ORR control room. A new monitron system has been installed with master control in the control room and monitors at several locations over the building. The new process instrumentation in the room adjoining the old control room were observed to be in working condition. Readings and settings appeared to be normal. Several switches on the "E" panel were observed to be on "test" and several on "run" positions. It was explained that, if one tried to turn a switch from "test" to "run", the reactor would scram.

2. Top of Reactor Structure

The area around the top of the reactor tank was observed to be clear and uncluttered now that the experimental leads have been removed. A second door has been installed and both entries are air locked, the open side of the building is now enclosed, and windows have been replaced.

B. OGR

Several instruments such as metal temperature, bulk air temperature, and radiation monitor readout were observed to be in operation in the control room. The access holes where the boron-steel rods had been placed in the reactor were blocked off and locked. Piping and conduits appeared to be blocked off in this area.

C. ORR

1. Control Room

The reactor was operating and all instrumentation, including the LITR remote-control console instrumentation, appeared to be operating normally. A new radiation monitor master readout station was observed to be in operation.

Operations log books were examined and seemed to include pertinent information, data, and rough sketches. Experiment check sheets and information sheets were compiled in a loose-leaf notebook which is available for Operations personnel. Information concerning the experiments in lattice positions B-9 and C-1 were checked

and appeared to be current and complete. Many different types of checklists were noted and checklists for each shift were being filled out.

2. Experimental Area

The GCR-ORR Loop II cell was viewed although the loop is shut down at present. The north engineering test facility is being converted into beam tube facilities at present and much construction work is evident. The beam tube areas were blocked off and radiation warning signs were posted. The experimental area, in general, appeared very crowded. Lock and tag procedures appeared to be acceptable and escape routes were plainly marked and were kept clear.

3. Control Rod Test Stand

An inspection of the new control rod drive unit and test stand at the Y-12 plant was made. Rod drives were observed on the test stand and the differences between these new drives and the present drives were noted. Some drives were disassembled and maintenance men were becoming familiar with assembly and disassembly of the drives. Rod drive magnet release times and time-of-flight data of the new rod drive units were examined.

D. Laboratory Waste Gas and Waste Liquid Systems

Discussions were held with members of the Laboratory's Radioactive Waste Control Group to determine if the ORR or LITR are aware whenever they are putting out abnormal amounts of radioactivity through the stack or the liquid-waste system.

Liquid low-level wastes are released through the plant low-level waste effluent system. Waste streams are continuously monitored and any significant change in radiation level is immediately brought to the attention of the releaser of the liquid.

The gaseous-release system is complicated since many tributaries enter into the stack system. The cost would be excessive to monitor each one for all possible radioactive effluents. All of the ducts entering the stack, however, are monitored both by tapes and by in-line monitors. Knowledge of processes going on in each section of the Laboratory and the process of elimination can usually determine the area from which the radioactive effluent is coming.

The ORR and LITR normal off-gas systems are tied to the central plant off-gas scrubbing system which is monitored before discharge into the stack. The ORR pressurizable off-gas system (POG) passes

through a carbon filter system and is monitored prior to stack discharge. The ORR and LITR building ventilation system air will be exhausted through carbon filter systems in the near future.

An inspection was made of the Waste Control Center and the various chart readouts. These readouts are closely watched and, if one begins to get too high, an investigation is made to determine the reason. The Waste Control Group issues weekly and monthly summaries of waste discharges.

Kenneth E. Elliott
Kenneth E. Elliott

Gene P. Coryell
Gene P. Coryell, Chairman

REFERENCE LIST

1. USAEC-ORO Safety Review of the ORR, LITR, and the OGR, March 25, 1963.
2. USAEC-ORO Safety Review of the ORNL Reactor Facilities, June 1962, CF 62-6-87.
3. Reactor Operations Quarterly Report, April-June 1963, CF 63-6-81.
4. Reactor Operations Quarterly Report, July-September 1963, CF 63-9-92.
5. ORR Quarterly Report, October-December 1963, CF 64-3-38.
6. LITR Quarterly Report, October-December 1963, CF 64-3-47.
7. ORR Quarterly Report (Rough Draft), January-March 1964.